

REMARKS

Claims 16-32 are pending in this application. By this Amendment, claims 16, 17 and 30 are amended. No new matter is added.

Priority

The Office Action asserts that the present application lacks the necessary reference to the prior application and that a statement reading "This is a Divisional of Application No. 09/236,347, filed 1/25/1999" should be entered following the title of the invention or as the first sentence of the specification.

However, Applicants respectfully note that the Continuing Application transmittal filed April 2, 2001 in this application clearly indicates that, with the checking of box 5 on the transmittal's front page, the specification is to be amended by inserting "This is a Division of Application No. 09/236,347 filed January 25, 1999. The disclosure of the prior application is hereby incorporated by reference herein in its entirety." Thus, Applicants believe it is not necessary to again make this amendment.

Claim Objections

The Office Action objects to claim 30 because the claim recites the limitation of 500 keV to 10 keV. Applicants have amended claim 30 as suggested by the Examiner to recite 500 keV to 500 eV. For this reason, reconsideration and withdrawal of the objection to claim 30 are respectfully requested.

§ 102/§ 103 Rejections

The Office Action rejects claims 16, 18 and 31-32 under 35 U.S.C. § 102(b) as being anticipated by Zhang et al. (U.S. Patent No. 5,578,520). The Office Action also rejects claims 17-32 under 35 U.S.C. § 103(a) as being obvious over Zhang et al. in view of one or more of Fan et al. (U.S. Patent No. 4,309,225), Asakawa et al. (U.S. Patent No. 5,795,385), Selvakumar et al. (U.S. Patent No. 5,633,194), Ichikawa et al. (U.S. Patent No. 5,484,746) and Krimmel (U.S. Patent No. 4,140,546). These rejections are traversed.

The Present Invention

The presently claimed invention is directed to a crystalline silicon film forming method including preparing a film forming apparatus having a silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on the target surface of the substrate, and an energy beam radiating device for irradiating said pre-film with an energy beam for crystallizing the pre-film. Thus, in the presently claimed invention, both the forming of the pre-film of the crystalline silicon film on the target surface as well as the irradiation of the pre-film are conducted in the vacuum chamber.

Zhang et al.

Zhang et al. teach a method for annealing a semiconductor in which a first chamber 2 is utilized for plasma CVD and a separate chamber 4 is used for laser annealing. Between the chambers 2 and 4 is a chamber 3 for a thermal annealing

furnace. According to Zhang et al., a "gate valve functions, for example, to avoid the reactive gas inside the chamber 2, i.e., the plasma CVD apparatus, from being introduced inside the thermal annealing furnace 3 being established for driving hydrogen out of the film" (see column 6, lines 25-29). Thus, it is clear that Zhang et al. do not teach a single vacuum chamber for both forming a pre-film and for irradiating said pre-film, and in fact, teaches against such a single chamber, since combining the chambers of Zhang et al. would lead to the reactive gas being introduced into the thermal annealing.

Thus, since Zhang et al. fail to teach or suggest a crystalline silicon film forming method in which a pre-film of crystalline silicon film is formed on a target surface of a substrate and the pre-film is irradiated in the same vacuum chamber, Applicants respectfully submit that the presently claimed invention is not anticipated by, and would not have been obvious, over Zhang et al.

Fan et al.

Fan et al. discloses a method of crystallizing amorphous film with a moving energy beam. However, Fan et al. fail to make up for the deficiencies of Zhang et al. In particular, Fan et al. fail to teach or suggest forming a pre-film of crystalline silicon film on a target surface and irradiating the pre-film in a single vacuum chamber, as required by the present claims.

Additionally, even if Fan et al. did teach forming a pre-film and irradiating in the same vacuum chamber, Applicants respectfully submit that it would not have been

obvious to modify Zhang et al. to include such a combination since the defects of the reactive gas inside the chamber being introduced into the thermal annealing would then be expected to occur.

Asakawa et al.

Asakawa et al. describes a method of forming single-crystalline thin film by beam irradiation. As is the case for Zhang et al., Asakawa et al. fail to teach or suggest forming a pre-film and irradiating in a single vacuum chamber. However, even if Asakawa et al. had taught such a combination in a single vacuum chamber, Applicants respectfully submit that it would not have been obvious to modify Zhang et al. to include such a combination since the defects discussed above for Zhang et al. would then be expected to occur.

Selvakumar et al.

Selvakumar et al. teach low temperature ion-beam assisted deposition methods. However, Selvakumar et al. fail to overcome the deficiencies of Zhang et al. In particular, as is the case for Zhang et al., Selvakumar et al. fail to teach or suggest film forming a pre-form and irradiating in a single vacuum chamber. However, even if Selvakumar et al. did teach such a combination, Applicants respectfully submit that it would not have been obvious to apply such a combination to the teachings of Zhang et al. since the defects taught by Zhang et al. would then be expected to occur.

Ichikawa et al.

Ichikawa et al. teach a process for forming a semiconductor thin film. Ichikawa et al. fail to overcome the deficiencies of Zhang et al. In particular, Ichikawa et al. fail to teach or suggest forming a pre-film and irradiating the pre-film in a single vacuum chamber. However, even if Ichikawa et al. did teach such a combination, Applicants respectfully submit that it would not have been obvious to apply such a combination to the teachings of Zhang et al. since the defects taught by Zhang et al. would then be expected to occur.

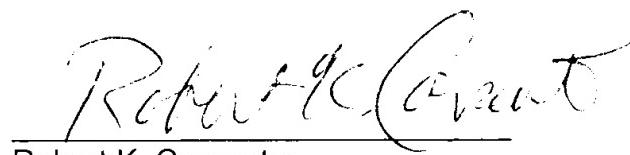
For at least the above reasons, the presently claimed invention is not anticipated by Zhang et al. nor would the presently claimed invention have been obvious over Zhang et al. alone or in any combination with any or all of the secondarily applied references. Reconsideration and withdrawal of the rejections under 35 U.S.C. § 102(b) and § 103(a) are respectfully requested.

Conclusion

Applicants respectfully submit that this application is in condition for allowance and such action is earnestly solicited. If the Examiner believes that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below to schedule a personal or telephone interview to discuss any remaining issues.

Please charge any fee deficiency or credit any overpayment to Deposit Account
No. 01-2300, referencing Docket No. 107351-00011.

Respectfully submitted,



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Attachment: Amended Claims Marked-up To Show Changes

Amended Claims Marked-up To Show Changes

16. (Amended) A crystalline silicon film forming method comprising the steps of: preparing a film forming apparatus having a single silicon film forming vacuum chamber for forming a crystalline silicon film on a substrate, and provided with a film forming device for forming a pre-film of the crystalline silicon film on a target surface of said substrate, and an energy beam irradiating device for irradiating said pre-film with an energy beam for crystallizing said pre-film;

locating the substrate in said silicon film forming vacuum chamber, and forming the pre-film of the crystalline silicon film on the target surface of said substrate by said film forming device; and

producing the intended crystalline silicon film from said pre-film by irradiating said pre-film in said vacuum chamber with said energy beam for crystallization of said pre-film emitted from said energy beam irradiating device subsequently to the formation of said pre-film.

17. (Amended) The crystalline silicon film forming method according to claim 16, wherein

said film forming device employs such a structure that can form said pre-film over a length, in a first direction, of the target surface of said substrate, said energy beam irradiation device employs such a structure that can irradiate the target surface of said substrate over the length in the first direction with the energy beam, and the intended crystalline silicon film can be successively formed by operating said film forming device to form said pre-film [in said first direction] on the target surface of said substrate, and

concurrently operating said energy beam irradiation device to irradiate the formed pre-film with the energy beam while moving said substrate in a second direction crossing said first direction.

30. (Amended) The crystalline silicon film forming method according to claim 25, wherein

an emission energy of said ion beam is in a range from 500 keV to 500eV [10 keV].